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Hybrid Optimization Algorithm for VM Migration in Cloud Computing

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Abstract

The number of cloud users and their respective workload increases everyday with the inherent benefits of cloud computing. On the other hand, it becomes critical for service providers to maintain Quality of Service (QoS) even under heavy workload conditions. In order to provide better computing services, cloud utilizes Virtual Machine (VM) migration techniques, which eases the process of providing the services to the user without any delay and with minimum energy consumption. The existing cloud computing services mainly rely on migration techniques; nevertheless, handling large VM migrations consumes more energy, which directly affects the VM performances. This necessitates the need to develop an effective VM migration strategy to perform the necessary migrations and avoid unnecessary migrations. Conventional migration techniques perform migration based on static parameters which attains less efficient results and lags in performance while handling the resource utilization. In this research work, a hybrid optimization algorithm is presented to handle VM migration in a cloud environment. Cuckoo search optimization algorithm and particle swarm optimization algorithm are combined to obtain the proposed hybrid optimization model. The major objective of this research work is to reduce energy consumption, computation time, and migration cost. Maximizing resource utilization is another objective of this research work. To validate the research objective, the performance of hybrid optimization model is verified through simulation analysis and compared with conventional algorithms like firefly optimization, whale optimization, hybrid whale optimization, and hybrid bee colony optimization in terms of energy consumption, migration cost, resource availability, and computation time.

Introduction

Cloud computing is one of the most successful financial establishments of the Information Technology (IT) sector. The virtual services are used in small-scale to large-scale organizations to compute and store the data. Instead of investing huge money in building a infrastructure, organizations are now preferring cloud services. Cloud provides a wide range of services similar to the physical resource but the major advantage is its virtual provisioning with which anyone can access the resource from any place and at any time. The pay-per-use policy of cloud service attracts more users towards the cloud. However, due to the advantageous features like compatibility, adaptability, and mobility, the number of cloud users are steadily increasing every day which in turn leads to high computational requirements. Cloud service providers must be aware of the expected as well as unexpected loads and their computational requirements to handle the user service requests. To achieve this, cloud service providers have introduced hybrid clouds, where the organization is provided with additional cloud resources as a complement along with the private cloud. This process avoids additional server requirements when the load is high and also the cloud resources can be used properly.

Commercial virtualization applications require more computational resources than the allocated complimentary resource which leads to virtual machine migration in the cloud computing platform. The complementary resources cannot be extended beyond a limit, however the loads must be handled effectively without violating the service level agreement and Quality of Service (QoS). In such cases, the under-utilized resources will be manually identified by the system administrator and later will be migrated to the heavy resource requirement applications. Most of the cloud service supports VM migration for achieving a better traffic management, less hardware maintenance, energy management, and server consolidation. The migration process is usually manual in conventional approaches. This leads to poor choices and increase in the expenses and downtime of the migration process. The major objective of VM migration is to reduce the energy consumption and cost, but the manual process increases both to a certain extent and therefore it requires an automated migration technique. Moreover, the migration should be precise and adaptable to the application environment.

The migration process is simply categorized into two cases as, live VM migration and non-live migration. The non-live migration holds the current process and a copy of all the pages from source to target and resumes the process once the migration is completed. The live migration does not stop the current process and it also requires a limited downtime to transfer the VM from source to destination. However, live VM migration is suitable for small-scale operations, transfering the entire VM to all the process is quite complex and difficult. Moreover, QoS requirements are generally not considered for single live VM migrations, and in that case, non-live migration is preferred. Though the downtime is high compared to live migration, instead of providing restricted services to the user during live migration, service providers prefer non-live migration with minimum downtime.

Several migration algorithms are proposed to identify the utilization status of the virtual machines so that the under-utilized machines can be migrated to the target systems when the resource requirements increase. Similarly, selecting a suitable VM for the migration process is crucial because the decision system must select the appropriate VM; otherwise, the performance of the VM and target application would decline, affecting QoS. Currently, the VMs are migrated based on the resource utilization of VM, target system VM requirements, the utilization of server resources like bandwidth, CPU utilization, etc., and Quality of Service (QoS). The major objective of this research work is to provide an efficient virtual machine migration strategy for cloud computing with enhanced QoS and minimum SLA (Service Level Agreement) violations. Various optimization models are evolved so far to handle VM migration; however, those systems are focused only on resource utilization. Similar to resource utilization, it is essential to perform migration by considering QoS and SLA factors for which the limited techniques are available and their performances can be improved further. To overcome these challenges, a hybrid optimization algorithm is introduced in this research work by integrating a cuckoo search algorithm and particle swarm optimization algorithm for achieving an efficient VM migration in order to minimize the energy consumption and enhance the performance. The major contribution of the research work is summarized as follows.

- A hybrid optimization algorithm has been presented by using cuckoo search algorithm and particle swarm optimization technique for VM migration.
- Hybrid optimization model performance is evaluated through simulation analysis and their performance analysis is presented.
- Comparative analysis of the proposed model with the existing migration techniques is presented in terms of load, energy consumption, resource availability, migration cost, and computation cost to demonstrate a superior performance.

The remaining part of the research work is arranged in the following order: In section2, various optimization models evolved for VM migration are analyzed and their features are discussed. In section3, the proposed hybrid optimized VM migration technique is explained. The simulation analysis and results are illutrated in section4 and finally the propsoed research work is concluded in section5.

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VM migrations are generally performed to reduce the energy consumption and achieve an effective resource utilization. The issues and challenges in VM migration are analyzed in terms of distance, manner, and granularity. The challenges in VM migration mainly rely on storage & memory data migration, and network connection continuity. Generally, the energy efficiency is achieved by reducing the load occurrences of physical machines with the prediction and monitoring approach. In other words,…

Proposed work

The proposed hybrid optimization model to select the optimal VM for migration is presented in this section. Optimization models like artificial bee colony optimization, ant colony optimization and other such models are widely used in the cloud and wireless sensor networks [21]. However, only a limited number of works have addressed the features of optimization models in VM migration. This research study proposes a hybrid approach by incorporating cuckoo search optimization and particle swarm…

Results and discussion

The performance of hybrid optimization algorithm in the VM migration process is verified through simulation analysis. CloudSim tool is used for cloud setup and the system configuration for the simulation environment is Intel i3 processor with 8GB memory. The operating system is windows 10. Totally 10 physical machines and 50 virtual machines are used for analysis and by varying the tasks, the performances are measured. Parameters such as migration cost, resource availability, energy…

Conclusion

In this research work, a hybrid optimization algorithm has been successfully developed for VM migration in cloud computing. Cuckoo search and particle swarm optimization algorithms are incorporated as a hybrid approach to perform VM migration. Based on the optimal solution obtained by the proposed approach, the VMs are migrated to the host in order to reduce the unnecessary migrations. Simulation analysis of the proposed model validates better performance in terms of energy consumption,…

Data Availability Statement

Data sharing not applicable – no new data generated

Compliance with Ethical Standards…

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.…

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Declaration of Competing Interest

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